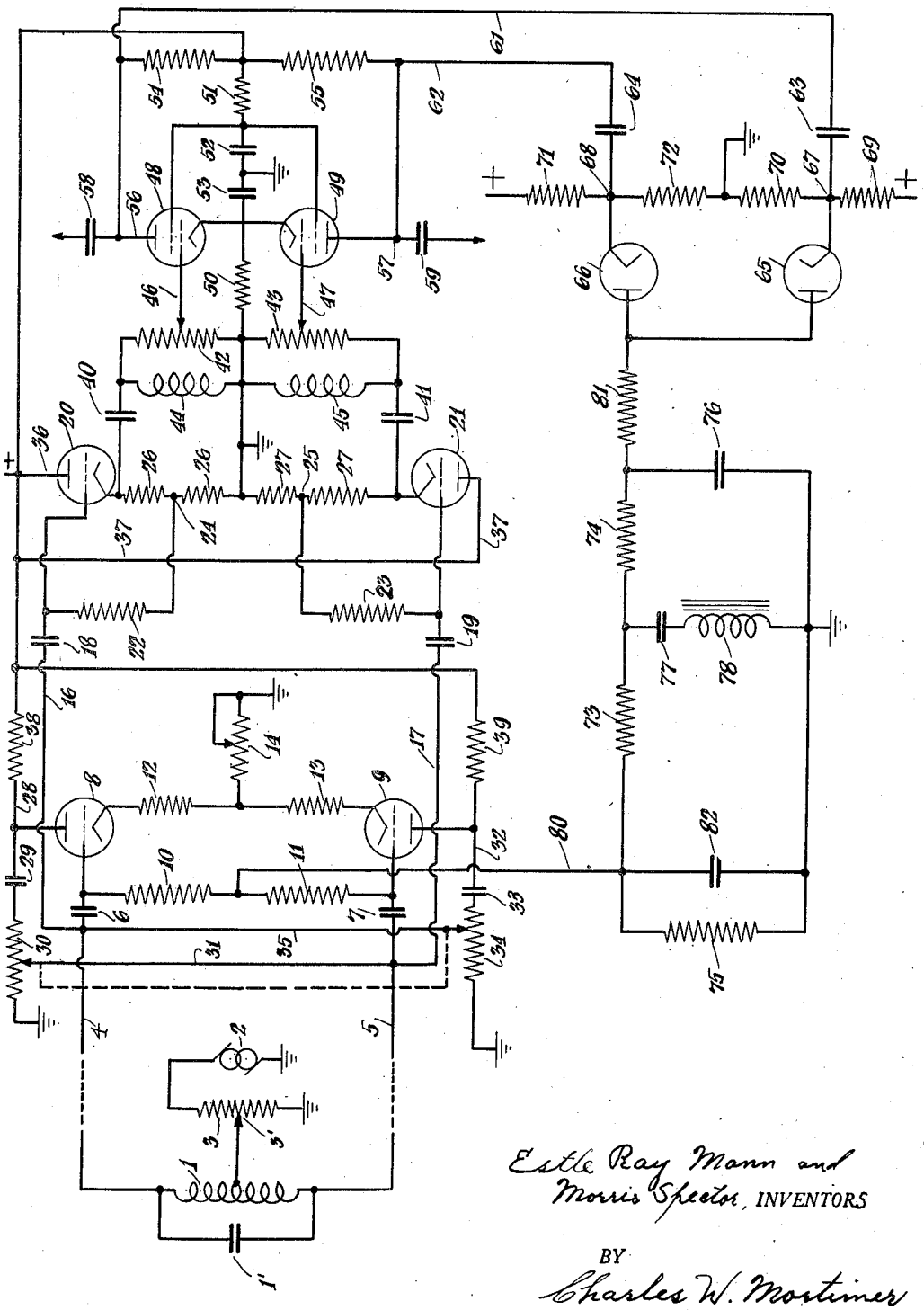
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STABILIZED MODULATED OSCILLATOR

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STABILIZED MODULATED OSCILLATOR

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This invention relates to a modulated oscillator in which provision is made by means of which the oscillator is kept sensitive and is also prevented from becoming overloaded. The oscillator is thereby stabilized.

Heretofore vacuum tube oscillators have been provided for testing or examining metals by placing pieces of the metals in or passing them through an inductance coil that is located in the grid tank circuit of the oscillator and modulating the oscillator by means of a low frequency voltage. The modulated output from the oscillator may be examined, for example, by means of an oscillograph, and since the pattern on the face of the cathode-ray tube of the oscillograph varies with the sort and condition of the metal placed in or passed through the coil, information relating to the metal is thereby rendered available.

Means are also available for selecting or sorting metal pieces by placing them in or passing them through such coils and utilizing the signals so produced for sorting or selecting the metal pieces.

It is desirable to make such oscillators both stable and sensitive. Stability can usually be secured by using push-pull vacuum tube circuits in the oscillator and providing symmetry of components and by modulating the oscillator by means of a stable signal of low frequency compared to that of the oscillator. In this way the oscillator can be made to oscillate and still be very stable even very near its quench point. The low frequency modulator supplies energy at all times regardless of the amplitude of the high frequency oscillations, thereby sustaining the high frequency oscillations, even when they are very close to their quench point, so that they do not become entirely quenched.

However, when the load is removed from the output of the oscillator the amplitude of the high frequency oscillations may increase to such an extent that the oscillator becomes so much overloaded that the output oscillations become objectionably distorted.

By the present invention, the oscillator is kept sensitive and is also prevented from becoming overloaded. That is, the oscillator is kept oscillating and the amplitude of the oscillations are prevented from becoming too large.

The invention may be understood from the description in connection with the accompanying drawing which is a diagram of connections illustrating the invention.

In the drawing, reference character 1 indicates a coil into which the metal to be tested is placed

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or through which it is passed. It is tuned by capacitor 1'. A source 2 of low frequency current, say 103 cycles per second, is connected to one end of resistor 3 the other end of this resistor being grounded. A sliding contact 3' on resistor 3 is connected to the center of coil 1.

The ends of coil 1 are coupled by leads 4 and 5 and capacitors 6 and 7 to the grids of push-pull oscillator tubes 8 and 9 which are provided with grid leak resistors 10 and 11, and with cathode bias resistors 12 and 13 connected to a common variable resistor 14 which is connected to ground.

The ends of coil 1 are also coupled by leads 16 and 17 and capacitors 18 and 19 to the grids of push-pull cathode biased amplifier tubes 20 and 21 which are provided with grid leak resistors 22 and 23 that are connected to intermediate points 24 and 25 on cathode bias resistors 26 and 27 of tubes 20 and 21, respectively.

The plate of tube 8 is coupled by lead 28, capacitor 29, and variable resistor 30 to ground. An adjustable contact on resistor 30 is connected by lead 31 to the lead 5. The plate of tube 9 is coupled by lead 32, capacitor 33, and variable resistor 34 to ground. An adjustable contact on resistor 34 is connected by lead 35 to the lead 4. This provides a push-pull oscillator of the known sort. The plates of tubes 20 and 21 are connected by leads 36 and 37 to a source of positive potential while the plates of tubes 8 and 9 are connected through plate load resistors 38 and 39 to the same source of potential.

The cathodes of tubes 20 and 21 are coupled by capacitors 40 and 41 to potentiometer gain control resistors 42 and 43. The choke coils 44 and 45, which are in parallel with the resistors 42 and 43, are filters to remove the low frequency modulating components that are introduced by the alternator 2. The sliding contacts and leads 46 and 47 couple the gain controls 42 and 43 to the grids of tetrodes 48 and 49. The cathodes of these tubes are biased by resistor 50 that is connected to ground as are the adjacent ends of resistors 42, 43 and inductance coils 44 and 45. A resistor 51 is provided in the usual way between a source of positive potential for the plates of tubes 48, 49 and the screen grids of these tubes, and capacitors 52 and 53 are provided between the screen grids of these tubes and the cathodes thereof and ground. The load resistors of tubes 48 and 49 are shown at 54 and 55.

The leads 56 and 57 and coupling capacitors 58 and 59 are for applying the amplitude modulated high frequency signals on the plates of tubes 48 and 49 to an indicating device not shown,

such as a cathode-ray tube, a meter, a lamp, a trigger circuit or a relay that are well known for observing or utilizing the high frequency envelope.

The plates of tubes 48 and 49 are coupled by leads 61 and 62 and capacitors 63 and 64 to the cathodes of diodes 65 and 66. These cathodes are set at a predetermined voltage level by connecting them to points 67 and 68, respectively, on voltage dividers 69, 70 and 71, 72 that are connected between sources of positive potential and ground. As long as the points 67 and 68 are at a potential level higher than the amplitude of a signal applied to the plates of these diodes 65 and 66 no current will flow through them. The signal fed into the cathodes of tubes 65 and 66 from the amplifiers 48 and 49 is the amplified amplitude modulated high frequency signal from coil 1.

The filter network comprising resistors 73, 74 and 75 and capacitors 76 and 82 contains a series resonant circuit consisting of the capacitor 77 and an inductor 78 in series. This resonant circuit 77, 78 is tuned to the modulating frequency which is the frequency of the source 2. A lead 80 connects a point between the resistors 10 and 11 to one end of this filter. A resistor 81 is connected between the plates of diodes 65 and 66 and said filter network.

The operation is as follows:

A positive potential is applied at the + point shown on the drawing above tube 20, whereupon the push-pull oscillator 8—9 begins to oscillate. The amplitude of the oscillations is adjusted by varying the resistors 14, 30 and 34, the latter two being varied together. This amplitude can be observed by means of the indicating device mentioned above for observing the envelope of these high frequency oscillations. The alternator 2 feeds a low frequency potential of say 103 cycles per second to the coil 1.

The amplitude of this potential is adjusted by positioning the contactor 3' on resistor 3 to provide the desired amount of modulating signal. This modulating signal aids in keeping the high frequency oscillations stable without causing the high frequency oscillator to lose sensitivity.

The stabilizing effect is also aided by providing symmetry of components in the duplicate portions of the oscillator.

Due to the core losses in the sample caused by the oscillating magnetic field of coil 1, the amplitude of the high frequency oscillations is decreased, thus causing the peaks of the modulated envelope to decrease. Such distortion is obviated with the present invention.

The output signals from the plate circuits of tubes 48 and 49 are coupled by leads 56 and 57 and condensers 58 and 59, respectively, to diodes and filter circuits which detect the envelope produced by the modulated oscillator. The signals having the amplitude and phase of this envelope taken from the leads 56 and 57 may be used in usual ways to produce useful indications on a cathode ray tube, a meter, or to operate a relay by means of a triggering device, for example.

If the amplitude of the oscillations were allowed to increase without automatic volume control means, the output from the oscillator would be an output from which the envelope had been removed from the amplitude modulated signal due to overloading of the oscillator or overloading the two amplifiers 48, 49 which follow the oscillator, or overloading both. With this invention, the amplitude of the oscillations are limited to a predetermined maximum so that overloading does not occur and therefore the envelope is not removed.

The sensitivity of the oscillator is greatest when it is operating near its quench point as is usual with oscillators of this sort. It is therefore desirable in using the device for a metal specimen in the test coil 1 to bring the amplitude of the oscillations to near zero. When this is done, if two metal specimens differing in some metallurgical properties are inserted in the test coil 1 one after the other, one of them will more nearly quench the oscillator than the other. The amplitude of the oscillations in the one case will be smaller than it will be in the other case. The amplitude of the envelope in the one case will also be smaller than it will be in the other case. If, however, the metal specimen is withdrawn from the test coil the amplitude of the oscillations will increase to such an extent that overloading will occur and the envelope will be removed unless provision is made for preventing this.

To prevent this overloading a negative voltage is inserted at the proper time, namely, as the core is being withdrawn, between resistors 10 and 11 so that the grids of the oscillator tubes 8 and 9 will be driven sufficiently negative to keep the amplitude of the oscillations down below the overload point. However, it is desirable that this prevention of overloading should not begin when the oscillator is near its quench point. If this were done the voltage fed back by means of the automatic volume control means would be equivalent to introducing degeneration in the oscillator and its attendant circuits. The introduction of this degeneration would serve the purpose of preventing overloading, but at the same time would diminish the sensitivity of the instrument so that it might not indicate the difference between core losses of two unlike metal specimens which differ only slightly.

Therefore, some delay is provided for in the automatic volume control means. This desirable delay is provided by the predetermined voltage that is applied at points 67 and 68 taken from the voltage dividers 69, 70 and 71, 72, respectively, so that the amplitudes of the output signals from the plate circuits of tubes 48 and 49 at which the diodes 65 and 66 are allowed to conduct is predetermined. Signal amplitudes below the voltages at 67 and 68 do not allow these diodes to conduct. By this means the automatic volume control is not applied to the oscillator so long as the amplitudes of the signals from plates of tubes 48 and 49 are lower than the potentials at 67 and 68, but is applied when these amplitudes exceed the potentials at 67 and 68.

By this means all the sensitivity desired for the oscillator is made available without degeneration when it is operating near its quench point. As the amplitudes increase when a specimen is removed from the test coil and when sensitivity is no longer desired the automatic volume control introduces degeneration and decreases the sensitivity when high sensitivity is no longer needed.

The signal rectified by diodes 65 and 66 contains a high percentage of the modulating frequency envelope. This rectified signal is filtered by the filter consisting of condensers 76 and 82, and resistors 73, 74 and 75 and the series network consisting of capacitance 77 and inductance 78 which is tuned to the modulating frequency. If this modulating frequency were not removed

from the rectified signal it would be reinserted at the point between resistors 10 and 11 of the oscillator and would remodulate the oscillator. This remodulation could be the same or different in both phase and amplitude from that inserted by the source 2.

With the delayed automatic volume control circuits, as a metal specimen is inserted in the test coil 1, the amplitude of the oscillator diminishes slowly at first until it drops below a voltage predetermined by the potentials at the points 67 and 68 because at voltages higher than this the oscillator is relatively insensitive. When the amplitude of the oscillations have dropped below this level further insertion of the specimen into the coil produces large changes in these amplitudes because without this automatic volume control the oscillator would be much more sensitive to changes in core losses that are produced by the presence of the metal that is inserted into the test coil 1. With this invention the oscillator retains its high sensitivity to small differences between core losses that are produced by different metals being in the test coil and, at the same time, this oscillator becomes relatively insensitive to the large core loss differences which are shown when the test coil has no metal core and when it has a metal core inserted into it.

What is claimed is:

1. A stabilized oscillator comprising a pair of vacuum tubes each having a control grid, a source of low frequency current connected to each one of said control grids to amplitude modulate the oscillations of said oscillator, push-pull cathode biased amplifiers having control grids to which the outputs of said pair of vacuum tubes are respectively coupled, a filter for said low frequency current located between the output terminals of said push-pull amplifiers and ground, a pair of diodes having cathodes to which said push-pull amplifiers are coupled respectively, and a filter for said low frequency current located between the control grids of said pair of vacuum tubes and the plates of said diodes.

2. The device of claim 1 in which push-pull amplifiers are located between said filter and said diodes and connected thereto.

3. A stabilized oscillator comprising a pair of vacuum tubes each having a control grid, a source of low frequency current connected to each one of said control grids to amplitude modulate the oscillations of said oscillator, push-pull cathode biased amplifiers having control grids to which the outputs of said vacuum tubes are respectively coupled, a filter for said low frequency current located between the output terminals of said push-pull amplifiers and ground, a pair of diodes having cathodes to which a source of positive potential and said push-pull amplifiers are coupled respectively, and a filter for said low frequency current located between the control grids of said oscillator and the plates of said diodes.

4. The device of claim 1 in which said filter is resonant at the frequency of said low frequency current.

5. The device of claim 1 in which resistors are located between a source of positive potential and the cathodes of said diodes.

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